

A SURVEY OF STUNNING METHODS CURRENTLY USED DURING SLAUGHTER OF POULTRY IN COMMERCIAL POULTRY PLANTS

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Primary Audience: Poultry Processors, USDA Personnel

SUMMARY

The Food Safety and Inspection Service (FSIS) conducted a 1992 telephone/FAX survey of all poultry slaughter establishments in the United States to determine the types and prevalence of stunning practices for each poultry class presently in use by the poultry industry. The survey revealed that electrical stunning was used in slaughtering greater than 90% of all birds except light fowl and geese. Low voltage-type electrical stunning devices (10 to 25 volts) were used in 216 of the 329 poultry slaughter plants, while 63 plants used electrical stunners set at a range of other voltages and amperages with unspecified waveforms and frequencies. Further studies monitoring voltage, amperage, and waveforms of electricity concurrent with somatosensory-evoked potentials are needed to determine the adequacy of electrical stunning as a humane practice.

Key words: Government regulations, poultry inspection, slaughter, stunning methods, USDA

1994 J. Appl. Poultry Res. 3:297-302

DESCRIPTION OF PROBLEM

The history of meat and poultry inspection in the United States can be traced back to colonial times when slaughter of livestock was conducted on a farm-to-farm basis and inspection procedures were rudimentary [1]. Since that time, increasing pressure placed upon government agencies by a more informed and concerned society has led to the passage of

laws and statutes ensuring a safe and wholesome meat and poultry supply.

The heightened consumer concern may be attributed to the fact that the nation has become more industrialized. The food animal population has greatly increased, and technological growth has provided vaccines, growth promoters, hormones, and antibiotics effective in controlling animal diseases, enhancing growth rates, and improving feed efficiency of

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large groups of animals. Concerns about the humane treatment of animals have also increased with the advent of mass production farming.

As a result of these societal pressures, the laws of meat and poultry inspection in the United States have been characterized by several enactments and amendments by Congress. In 1958, Congress passed the Humane Slaughter Act [2], amended in 1978. This Act mandates the use of humane methods for pre-slaughter handling and immobilization of all livestock under USDA inspection [3]. Specifically, in the case of livestock not exempted for religious reasons, all animals must be rendered insensible to pain by a single blow, gunshot, electrical, chemical, or other rapid and effective means, before being shackled, hoisted, thrown, cast, or cut. When slaughtering in accordance with the ritual requirements of the Jewish or other religious faith that prescribes a method of slaughter, no pre-slaughter immobilization is required. The animal, however, loses consciousness due to brain hypoxia resulting from the simultaneous and instantaneous severance of the carotid arteries with a sharp instrument.

The Humane Methods of Slaughter Act of 1978 does not cover poultry. USDA Poultry Inspection Regulations state that "Poultry should be slaughtered in accordance with good commercial practices in a manner that will result in thorough bleeding of the carcasses and ensure that breathing has stopped prior to scalding" [4]. As a result of increasing societal pressures concerning the welfare of poultry slaughtered, Congressman Andrew Jacobs (D-Indiana) introduced a bill in the House of Representatives in 1992 and again in 1993 to amend the Poultry Products Inspection Act to require that slaughter of poultry and the processing of poultry products in federally inspected establishments be performed in accordance with humane methods [5].

MATERIALS AND METHODS

POULTRY STUNNING METHODS

Poultry can be immobilized by inhaling carbon dioxide (chemical stunning) [6, 7] or by receiving a sufficient amount of electrical current through the brain (electrical stunning) [8, 9]. Smaller facilities and ritual slaughter operations do not stun; they kill birds by cutting the neck and incising one or more major

vessels (carotid arteries and/or jugular veins). Currently, the practice of choice for stunning poultry in most of the 329 slaughter plants in the United States is electrical. Most of the large slaughter facilities use electrical stunning by applying either alternating or direct current. After stunning, death is induced by incising the neck with an automatic neck cutter, which guides the neck across a rotating blade [10]. During this event the following might occur:

- the spinal cord and both carotid arteries are severed;
- the jugular vein plus the carotid artery are severed on one side; or
- the incision is made across the whole underside of the neck and both carotid arteries and jugular veins are severed.

The setting of the kill machine determines which blood vessels are severed by the single- or double-blade automatic neck cutter. Adjustments are made to vary the distance between the guide rail and the blades. The adjustments also control the orientation of the bird's head as it passes through the cutter. Equally important are settings that determine the depth of the cut. Together, all these factors help determine which blood vessels are severed. The settings used are under the control of the abattoir staff who check the setting of the blade before each shift or change in class of bird slaughtered.

SURVEY METHODS

A telephone/FAX survey was conducted of all poultry slaughtering establishments in the continental United States by FSIS region during 1992. Each plant was asked to provide the following information:

- the type of stunner, if any, used in the plant;
- the operating voltage and amperage used to stun birds; and
- whether or not ritual slaughter was performed.

Data detailing the number of birds slaughtered by class and the number of slaughtering plants for FY 1991 were obtained from USDA, FSIS, and the Statistics and Data Systems Division. The number of birds slaughtered remains fairly consistent within any three-year period. A comparison was made of plants responding to the telephone/FAX survey to the total number of plants operating in the United

States during 1991. An estimate of percentage by class was made for birds slaughtered using electrical stunning devices and birds slaughtered without stunning.

RESULTS AND DISCUSSION

Of the approximately 6.6 billion birds slaughtered in the United States during FY 1991 (Table 1), 6.1 billion (92%) were represented in this survey. Electrical stunning was performed in 92% of young chickens, 6% of light fowl, 97% of heavy fowl, 95% of young turkeys, 98% of young breeder turkeys, 99% of old breeder turkeys, and 86% of ducks (Table 2). Virtually all of the remaining birds of these classes were slaughtered without stunning by severing the carotid arteries or decapitation. Light fowl (93%) and geese (100%) were slaughtered primarily by severing the carotid arteries. No geese were electrically stunned. The number of turkeys stunned by carbon dioxide represented approximately 5% of total turkeys and 0.08% of the total birds slaughtered.

Of the 329 poultry slaughter plants in the United States, 279 (85%) reported using some

type of electrical stunning device during their slaughter operations. Approximately 216 plants (66%) reported using stunning devices which operated specifically at low voltages (10 to 25 volts). These employed a pulsating direct current with a frequency of 500 Hertz and 200 to 400 milliamperes (Table 3). Sixty-three plants (19%) reported operating stunning devices at an unspecified variety of waveforms (alternating or direct current) with a voltage range of 7.5 to 600 volts and a current range of 0.3 to 10 amperes.

The efficacy of the resulting stun was determined by observing corneal and comb reflexes. Usually plant personnel classified birds as stunned when a state of unawareness and unresponsiveness was induced and the eyes were wide open, the neck was arched, and the wings were tucked. Approximately 49 (15%) of the plants reporting did not use electrical stunning. Slaughter was performed in these plants by incising the major blood vessels of the neck. Only one plant reported using carbon dioxide as a stunning agent (Table 3).

Birds are usually checked for effectiveness of stunning technique by testing the comb

TABLE 1. Number (thousands) of poultry slaughtered in the United States (1991)

NUMBER OF ANIMALS SLAUGHTERED								
Young Chickens	Light Fowl	Heavy Fowl	Young Turkeys	Young Breeder Turkeys	Old Breeder Turkeys	Ducks	Geese	Total
6,145,418	123,638	47,378	272,296	1,244	2,261	21,065	196	6,613,499

TABLE 2. Number (thousands) and percent of birds reported slaughtered in the United States using various stunning devices (1991)

CLASS	TYPE STUNNING DEVICE USED			
	Electrical	Religious Slaughter	Other ^A	Total No. Reported
Young chickens	5,668,025 (92.10) ^B	44,946 (7.90)	135 (0.00)	5,713,106 (100)
Light fowl	8,034 (6.51)	39 (0.03)	115,343 (93.46)	123,416 (100)
Heavy fowl	13,232 (96.72)	7 (0.06)	440 (3.22)	13,679 (100)
Young turkeys	242,561 (94.98)	7,170 (2.81)	5,845 (2.29)	255,576 (100)
Young breeder turkeys	1,000 (97.93)	0.6 (0.06)	124 (2.01)	1,124 (100)
Old breeder turkeys	2,106 (98.97)	0	22 (1.03)	2,128 (100)
Ducks	14,939 (85.63)	1,365 (7.83)	1,141 (6.54)	17,445 (100)
Geese	0	128 (70.94)	52 (29.06)	180 (100)
Total	5,949,897 (97.23)	46,485 (0.76)	123,102 (2.01)	6,119,484 (100)

^ARepresents slaughter by decapitation

^BNumbers in parentheses indicate percent of total birds reported

TABLE 3. Number of plants in the United States using various stunning devices during poultry slaughter operations

LOCATION REGION	DC VOLTAGE	AC OR DC VOLTAGE	NO STUNNER: SLAUGHTER BY EXSANGUINATION	CARBON DIOXIDE	TOTAL # OF PLANTS
	10–25 Volts, 500 Hz	7.5–600 Volts			
Northeast	34	2	24 (12) ^A	0	60
Southeast	85	33	0 (0)	0	118
North Central	26	9	9 (5)	1	45
Southwest	55	7	2 (0)	0	64
Western	16	12	14 (13)	0	42
Total Plants	216	63	49 (30)	1	329

^ANumbers in parentheses indicate plants reporting religious slaughter operations

pinch, pedal, and corneal reflexes [11]. In conscious birds the skin of the comb is said to be more sensitive to painful stimuli than the skin of other parts of the body. Pinching the comb results in withdrawal and shaking of the head. Pinching the foot results in flexing or extension of the leg, and touching the cornea results in closing of the eyelids. Suppression of such physical responses is commensurate with a loss of sensation to touch and other painful stimuli and is usually used in assessing levels of surgical anesthesia.

Some individuals are not confident that electrical stunning, when applied in practice, is as reliable as plant managers and instrument manufacturers claim [12]. Suggested reasons for an increased resistance and interruption of stunner current flow are: 1) birds improperly stunned because of low voltage settings; 2) birds insufficiently submerged in the water bath; and 3) birds raising their heads and completely missing the stunner.

Inadequate stunning of the bird might adversely affect the efficiency with which the neck is cut, thereby causing birds to enter the scald tank before death. This could result in condemnation of the carcass as a cadaver during inspection. If the number of cadavers reported is attributed to the incidence of inadequate stunning, the percentage of birds disposed of as cadavers is low when compared with the total number slaughtered in FY 1991 [13]. Birds by class disposed of as cadavers were 0.03% for young chickens, 0.03% for young turkeys, 0.06% for mature turkeys, and 0.04% for ducks. However, improper stunning is not the only reason live birds might enter the scald. Other causes include properly

stunned birds missed due to variation in bird size or improper setting of the automatic killer.

The physiology of electrical stunning has been described in the literature. Electrical stunning inhibits impulses of the brain which include impulses of the reticular activating system (RAS) and somatosensory impulses [14, 15]. RAS impulses produce the conscious, alert state that makes perception possible. RAS is nonspecific and responds with equal facility to various sensory stimuli. Any agent (chemical, physical, or electrical) which can depress conduction in the RAS can produce unconsciousness.

The somatosensory evoked potentials (SEPs) of the brain are specific. That is, certain neurons in the brain are activated by only one type of stimulation. Evoked potentials resulting from sensory stimulation range in magnitude from 200 to 300 microvolts [16]. There has been much discussion in the literature concerning the effect of electrical stunning on spontaneous electroencephalogram (EEG) and somatosensory evoked potentials [15].

Gregory and Wotton [17, 18] were able to monitor evoked potentials. They were the most recent investigators to conclude that an absence of SEP is directly related to brain failure. They reported that using alternating current of 50 Hertz (low frequency) and 120 milliamperes for four seconds abolished SEP's in the brain of broiler chickens. Cardiac arrest was observed in 90% of birds stunned [17]. When birds were stunned with pulsating direct current of 350 Hertz (high frequency) and 120 milliamperes for four seconds (no voltage reported), 13 of 14 broilers lost SEP, and ventricular fibrillation was not observed

with the high frequency seen with direct current [17]. Loss of SEP, which indicates a profound form of brain failure, is more definitive as a measure of insensibility after stunning than absence of neck tension, comb pinching, avoidance, or vocal reflexes.

Survey findings indicate that currents presently employed under routine poultry slaughtering conditions are usually higher than those reported in the literature but are applied to several birds instead of to a single bird. The lower currents reported in the literature are capable of inhibiting SEP in a single bird, but the effect that stunning under routine slaughter conditions (10 to 25 volts, 200 to 400 milliamperes and 500 Hertz) might have on SEP and consciousness of birds has not been delineated.

Electrical stunning also affects carcass quality. Damage to the carcass which is sometimes associated with electrical stunning may reduce the quality of dressed carcasses [19]. Low voltages of alternating current with a sinusoidal wave of 50 Hertz at 130 milliamperes were reported to cause ventricular fibrillation and hemorrhage of heavy muscles of the tho-

racic cavity. It has been reported that spent laying hens (light fowl) develop broken bones and hemorrhagic areas in the thorax, on wing tips, and other anatomical structures when stunning is carried out using either alternating or direct current at low voltages [18]. If the voltage is increased, the incidence of broken bones, diminishing carcass quality, or cardiac arrest increases to a point and then decreases. Electrical stunning has also been reported to cause hemorrhaging of the skin and deep breast and leg muscles [20]. Such incidents cannot be correlated with either high- or low-frequency stunning.

Electrical stunning, when compared with carbon dioxide or argon gas as a stunning agent, has been reported to have no significant effect on efficiency of bleeding of broilers [21]. When broilers were stunned with 45% carbon dioxide, argon gas, or an electric current (77 or 104 milliamperes at 50 Hertz), the rate of bleeding was highest in the electrically stunned broilers during the first 60 sec. After 140 sec all broilers had bled out to a similar extent (30 to 33 g of blood/kg live body weight).

CONCLUSIONS AND APPLICATIONS

1. This survey on poultry stunning methods provides recent information about the number of birds slaughtered by class, stunning practice, and type of stunner employed during slaughter operations. Such information is of value to the government, industry, and consumers.
2. Future legislation concerning humane slaughter of poultry will require the consideration of definitive data on the science of stunning as well as the number of animals slaughtered.
3. Data obtained as a result of this survey are consistent with the following premises:
 - a. the voltage, amperage and frequency applied to each bird being slaughtered in federally inspected establishments is unknown;
 - b. the poultry industry has taken voluntary steps to fulfill humane requirements during slaughter operations in a preponderance of cases in compliance with regulations found in the Humane Methods of Slaughter Act of 1978;
 - c. birds are stunned using a duration, magnitude, and intensity of current which ensures a loss of consciousness that persists for a period sufficient for exsanguination;
 - d. to complete definitive research on stunning, information derived from using an oscilloscope and amperage meter would be needed in order to assess the voltage, amperage, and waveform of electrical current applied to each bird while being stunned for various stunning devices used in poultry slaughter operations;
 - e. more electrophysiological studies should be conducted to further characterize the electrical stunning process and to provide a scientific basis for future legislative and regulatory actions.

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